Black Magic

Examine what makes up the ink in your markers and pens while exploring chemical concepts!

Materials

- Clear plastic or glass cup/jar/bottle
- Coffee Filter or Paper Towel (cut into strips ~ 2 in wide and 6 in tall)
- At least 2 different black pens/markers (ex: Expo Vis-à-vis, Crayola Marker, Papermate Flair Pen, Sharpie Permanent Marker)
- Water
- Optional: rubbing alcohol, pencil and tape

Concepts to Explore

- Capillary action
- Chromatography
- Polarity
- Intermolecular Forces

Activity Format

- Have students write down ***detailed observations*** and include ***drawings*** as they work through the activity

- Students may answer the focus questions using the "**Claim, Evidence, Reasoning**" format:
  - Claim that answers the question
  - Evidence from students' data
  - Reasoning that involves a rule or scientific principle that describes why the evidence supports the claim

Procedure

Follow these steps for <u>each pen/marker</u> you plan on testing (if possible, try to use one *washable* marker and one *permanent* marker):

1. Fill a clear cup or glass with a small amount of water (less than 1 inch)
2. Draw a dot from your black marker in the center of the paper. <u>Make sure that the ink spot will remain above the water level when you place it in the cup</u>
3. Place your marked paper strip in the water cup (optional: tape your strip to a pen and place the pen over the container opening so that the paper strip stays upright)
4. Take the strip out to dry once the water has almost reached the top of the paper
5. Optional: repeat steps 1-4 but with rubbing alcohol.

Focus Questions

<u>Grades PreK-2</u>

1. What happened when you put the paper in water?
2. How many colors did you see? How many different ways do you think you can make the color "black"?
3. What happens if the ink spot does not stay above the water level when you put the paper in the cup (if you did not make this mistake, go ahead and try it!)? Why do you think this happens?
4. Sketch what you think is going on between the paper, water, and colors in the marker in this activity

<u>Elementary</u>

1. What makes up the color black? Why might it be useful to know what makes up a black marker?
2. What do you think causes the different parts making up the black ink to separate?
3. What did you notice about how the ink separated in the washable marker and the permanent marker? What do you think makes a marker "washable" vs. "permanent"?

4. Which colors moved up the paper more easily? Which colors tended to stay towards the bottom of the paper? Explain your answer by sketching a diagram showing the interaction between
    a. Two water molecules
    b. A water molecule and a cellulose (in paper) molecule
    c. A water molecule and a color dye molecule
    d. A color dye molecule and a cellulose (in paper) molecule

Middle School

1. Are all black pens/markers made up of the same inks? Why might it be useful to separate something into its individual components?
2. How does capillary action affect how the ink moves up the paper? Can you think of other examples of capillary action you might find around you?
3. What did you notice about how the ink separated in the washable marker and the permanent marker? Based on what you know about water, what do you think makes a marker “washable” vs. “permanent”? Do you think there is a way to examine the individual inks making up a permanent marker?
4. How are cohesion and adhesion relevant to how the different colors are separated? Explain your answer by sketching a particulate diagram showing the interaction between
    a. Two water molecules
    b. A water molecule and a cellulose (in paper) molecule
    c. A water molecule and a color dye molecule
    d. A color dye molecule and a cellulose (in paper) molecule

High School

1. Is black ink a pure substance or a mixture? Why might it be useful to separate or isolate a sample made up of multiple components?
2. How do polarity and molecular size affect how the colors separate on the paper?
3. What did you notice about how the ink separated in the washable marker and the permanent marker? Based on what you know about the polarity of water, what do you think makes a marker “washable” vs. “permanent”? How might you dissolve or separate the components of a permanent marker? Could you also use this method to separate the components of your washable marker?
4. How are intermolecular forces related to the process of chromatography? Explain your answer by sketching a particulate diagram showing the intermolecular forces between
    a. Two water molecules
    b. A water molecule and a cellulose (in paper) molecule
    c. A water molecule and a color dye molecule
    d. A color dye molecule and a cellulose (in paper) molecule

Design/Extension Opportunities

- Explore how using a different paper (i.e. paper towel, index card) and liquid (i.e. salt water, rubbing alcohol, acetone) affects how the black ink separates
- Flinn’s Chromatography Challenge

Photo References